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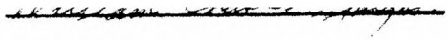

SOME EFFECTS OF WEAVING TENSIONS ON FABRIC STABILITY

A THESIS

Presented to

the Faculty of the Graduate Division

by

William Charles Knight

In Partial Fulfillment

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Master of Science in Textiles

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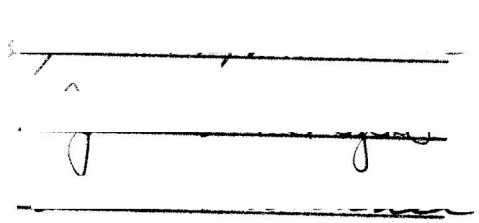
SOME EFFECTS OF WEAVING TENSIONS

ON FABRIC STABILITY

Approved:



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ACKNOWLEDGMENTS

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SUMMARY

In fabric production the uniform adjustment of warp and filling tensions during the weaving process has in many cases been neglected. It was the purpose of this study to determine the effects of this neglect by determining some of the characteristics of fabrics woven at various tensions.

The warp and filling used for the production of the test samples were obtained from a mill and were standard in the mill's production of 41" 62 x 40 2.20 sports denim. Two groups of samples were produced under identical conditions. These were woven at three levels of warp and filling tension resulting in nine different samples in each group. One of these groups was tested in the greige and the other was sanforized before being tested. The yarn used in both warp and filling was 12.7^{s}. The test fabrics were produced on a Draper XD loom equipped with a 20 harness dobby and a Bartlett let-off. A Brush Electronics Tension Analyzer was used for the tension measurements of both warp and filling. Warp tensions used were 40, 60, and 80 grams per end with the shuttle tension set at 12, 24, and 36 grams.

The results of the tests on both the greige and sanforized samples did not show an appreciable difference in characteristics as the shuttle tension was changed. This was due to the shuttle being at rest before the warp closed on the filling and the pick was beaten into the cloth.

In the greige samples it was found that an increase in warp tension caused a decrease in fabric width, an increase in sley and pickage,

and an increase in yards per pound. This increase in warp tension also resulted in a decrease in breaking strength both warp and fillingwise, an increase in shrinkage warpwise, and a decrease in shrinkage fillingwise.

The results of the sanforized test showed an opposite effect in some cases from those found in the greige fabric. As we increased the warp tension on the sanforized sample it was found that the width increased, the sley and pickage increased, and the yards per pound decreased. Further results showed that breaking strengths were increased both warp and fillingwise, and shrinkage increased in the direction of the warp and seemed to have little affect on the fillingwise shrinkage.

It should be kept in mind that this study covered only one fabric made from a three harness twill weave. Variations in yarn counts, constructions, and weave would certainly have varying effects on fabric characteristics. It would be enlightening to carry this study further in an effort to establish the extent of these variations.

CHAPTER I

INTRODUCTION

The problem of correct tension of both the warp and filling during the weaving process has always been difficult. In most textile mills today emphasis placed on this question is usually in the direction of greater production or higher loom efficiency. Even with this approach, the actual adjustment of these important tensions has been left to the guesswork of the loomfixer. Many mills do not use tensiometers or gauges of any kind to make these adjustments. Even the most qualified technicians are unable to achieve uniformity of tension over the entire weave room or over a group of looms running the same type of fabric. This nonuniformity of tension could produce fabrics whose characteristics are not uniform. Some of these variations thus produced are far from negligible as reported by Crawshaw, Morton, and Brown in a paper, "Experiments in Fabric Testing."[1] In this work the authors were reporting the influence of warp tensions during the weaving of plain cloth on surface abrasion.

The characteristics of a fabric are due to a great extent to the strains present in the yarns that make up the fabric and the resultant strains caused by these yarns being interlaced. Fibers and yarns are placed in a state of stress from the beginning of the fiber processing through to the finished fabric. There is an interesting statement made by Harwood in his paper, "Problem of Shrinkage": "The amount of this

tension and to what degree it becomes 'set' in the finishing process, is to some extent responsible for any shrinkage which may occur in a cotton fabric."[2] The resultant forces set up by these stresses can cause variations in crimp, elasticity, and strength in the final fabric. This study was not concerned with the strains set up in the yarns prior to the weaving process.

In a report by Morton and Williamson, "Properties of Plain Cotton Cloth,"[3] appears the following:

> When the pick is first inserted in the shed, it lies in practically a straight line and is either at zero tension or some small positive tension depending on shuttle drag. Under all ordinary conditions this tension is likely to be small because the shuttle has already come to rest before the shed has closed over weft. By the time the beat-up has taken place, the shed has crossed over and the scissors-like action of the warp has caused the weft to depart from its straight alignment and to assume a share of the crimp without which, in one or both sets of threads, cloth cannot be formed. In absence of any restraint, this crimping of the weft would cause the selvages to draw closer to one another; but as things are, the temples keep the cloth stretched out and in consequence the weft can crimp only by stretching. Hence, in the region between the temples, both warp and weft are in a state of tension, each endeavoring to straighten at expense of the other.

In this same report,[4] the authors bring out that the picks per inch are higher close to the fell of the cloth than they are after the cloth has been released by the temples. After the cloth has been removed from the loom and the tension removed from the warp, the picks per inch would increase slightly. This increase in pickage would be accompanied by an increase in crimp. Townsend states in his report on "Weft Tension in Weaving" that, "A perfect weaving machine would produce a warp with threads uniformly tensioned, and would interlace them with weft which was equally tensioned on every pick."[5] This would result in stress that was equal in

both directions, and could be an ideal situation for some fabrics. In the weaving process, using looms of current construction, the tension of the warp and filling can be accurately controlled. Modern looms are equipped with let-off motions which, if properly adjusted, keep warp tension quite uniform at the predetermined tension. In respect to the filling, this too can be controlled with the use of fur bristles, nylon loops, or adjustable tensioning devices built into the shuttle. In Snowden's paper, "Some Aspects of Warp Tension," the following is found:

> To weave loosely sett cloths, very little tension need be applied to the warp. All that is required is enough to prevent the warp threads from drooping to interfere with the shuttles as they move to and fro. If the cloth is firmly sett, however, a fair degree of tension is essential in order to obtain the required number of picks per inch.[6]

It can be seen from the above quotation that different types of fabrics will require different tensions during weaving. Snowden[7] further states that warps should be adjusted to the minimum tension for satisfactory weaving and care should be taken so that they will not be over-tensioned.

When the yarns of a fabric are interlaced, they bend partially around one another. This bending is known as "crimp" and it tends to shorten the given length of yarn. The amount of this crimp is determined by the size of the yarns, the frequency of the interlacing, and tension of the two systems at the time of interlacing. If one system is under loose tension and the other tight, it would be expected that the loose tension system would do more of the bending. If systems are of equal tension and equal size, the crimp of both systems should be approximately equal. From the foregoing discussion one should expect the tension at

the time of interlacing to affect the crimp of the yarns that make up the fabric.

The strength and elongation of a fabric is determined not only by the strength of the yarns but also by their ability to rearrange themselves so as to equalize the stress. Since this is true, it should follow that the type of weave and the crimp available in the yarns should affect the strength and elongation.

A very important characteristic of a fabric which is desired to be uniform is its ability to shrink. To determine just what effect these tensions have on the shrinkage characteristics of a fabric is one of the main purposes of this study. Collins, in his paper "Fundamental Principles That Govern the Shrinkage of Cotton Goods by Washing," states:

> Since both cotton fibers and yarns in themselves can only show at most a shrinkage of only a few per cent it is evident that the large shrinkages that can occur with cotton fabrics must be due to some feature or features peculiar to the fabrics themselves. The explanation of the shrinkage of a fabric does, in fact, lie in the structure and an extended account of the several aspects of the mechanism of shrinkage in relation to the structure is given in the Memoir issued from the Shirley Institute, entitled "The Geometry of Cloth Structure." [See No. 9 in Bibliography] [8]

In Peirce's[10] paper he discusses the effects of fabric structure on crimp, strength, elongation, cover factors, and fabric thickness. Since all of the above factors contribute to a fabric's shrinkage characteristics, it can be seen that fabric shrinkage is to a certain extent dependent on fabric structure.

Thus far, the factors have been mentioned that affect the characteristics of a fabric. Most of the material referred to discusses the effects on greige cloth without carrying these effects into the finished

fabric. It is the purpose of this study to determine the differences, in the fabrics produced, that can be traced to the amount of tension on the yarns at the time the yarns were interlaced or woven into a fabric. Some of these characteristics may change during certain finishing processes due to either chemical or mechanical treatment. Effects were determined in a fabric woven at different warp and filling tensions. They were also determined for the fabric at each tension level in both the greige and the sanforized state.

Some of these effects may be unimportant and others may be quite important. This study was made on a three harness twill fabric known to the buying public as a sports denim.

CHAPTER II

INSTRUMENTATION AND EQUIPMENT

The loom selected to produce the test fabric was a Draper Model XD, equipped with a 20 harness dobby. The principal reason this loom was chosen was that the let-off was a Bartlett and it was thought that the uniformity would be better if this type of let-off were used. With extreme warp tension on a dobby, the harnesses have a tendency to be lifted upward when the shed is down. To assure a positive action, double springs were used on all harness. Some of the other features and settings were as follows:

Let-off	Positive Bartlett
Take-up	Intermittent
Sandroll Cover	Synthetic
Warp Stop Motion	Electric
Filling Stop Motion	Center fork
Shuttle Eye	Synthetic, Adjustable Pads
Whiproll setting	Level Top Shed
Whiproll timing	3/4" Before Front
Harness timing	Fell 2¼
Loom speed	160 P.P.M.
Width of Loom	46"

A shuttle with adjustable tensioning pads was selected to facilitate duplication of filling tensions on repeated samples. It was also

thought that the tension would remain more uniform throughout any given sample.

It was imperative that the instrument used for the measurement of tension on the warp and filling possess the greatest accuracy possible. The Brush Electronics Tension Analyzer was selected because it was felt that the tension could be more easily and more accurately controlled with this instrument. The use of the Tension Analyzer would permit the duplication of conditions on repeating samples and assist in setting the shed, drop wire bars, and whiprolls. A photograph of this instrument will be found on pages 8 and 9 of this report showing its use to check the warp and filling tensions respectively. By the use of the charts shown on page 10, one can follow the complete picking cycle and determine when the yarn is under the greater strain. This can be of great assistance in setting up the loom. A study can also be made of the variation in tension due to the weave. In the case of this study there was a three pick cycle to the repeat. The Tension Analyzer was also used in the adjustment of filling tension. The chart on page 11 can be analyzed for this tension. This, of course, does not give the actual tension while the pick is interlaced but it is relative.

The filling was wound on cones which made the quilling operation necessary. For this rewinding process a Whitin-Schweiter Winder was selected. This machine is very consistent in winding tensions and will hold an adjusted tension exceptionally well. Two heads were adjusted and all filling was quilled on these. Winding tension set on these quillers was 40 grams maximum winding tension. This machine was built by Whitin Machine Works, Whitinsville, Massachusetts.

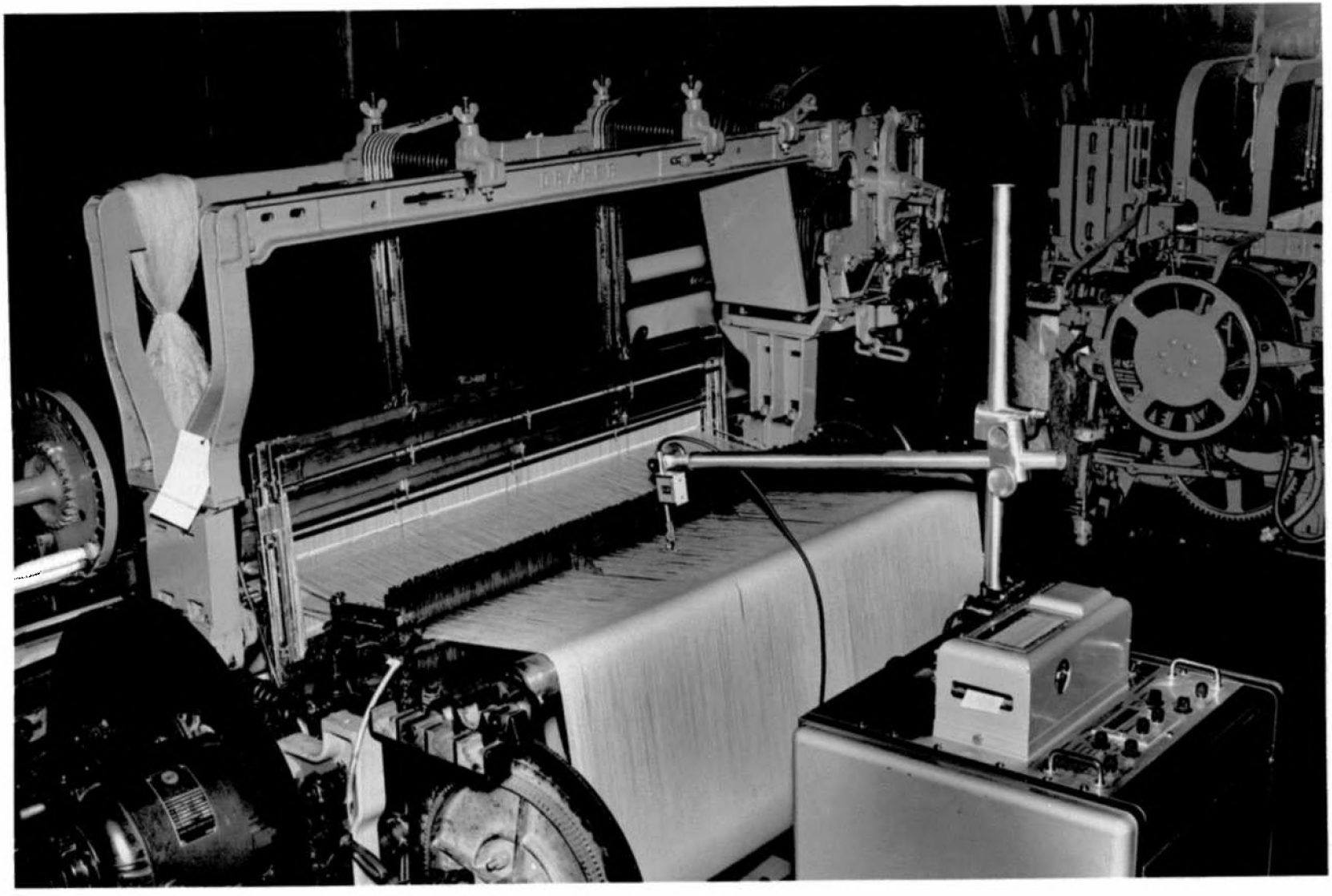


Figure 1. Brush Tension Analyzer Recording Warp Tension

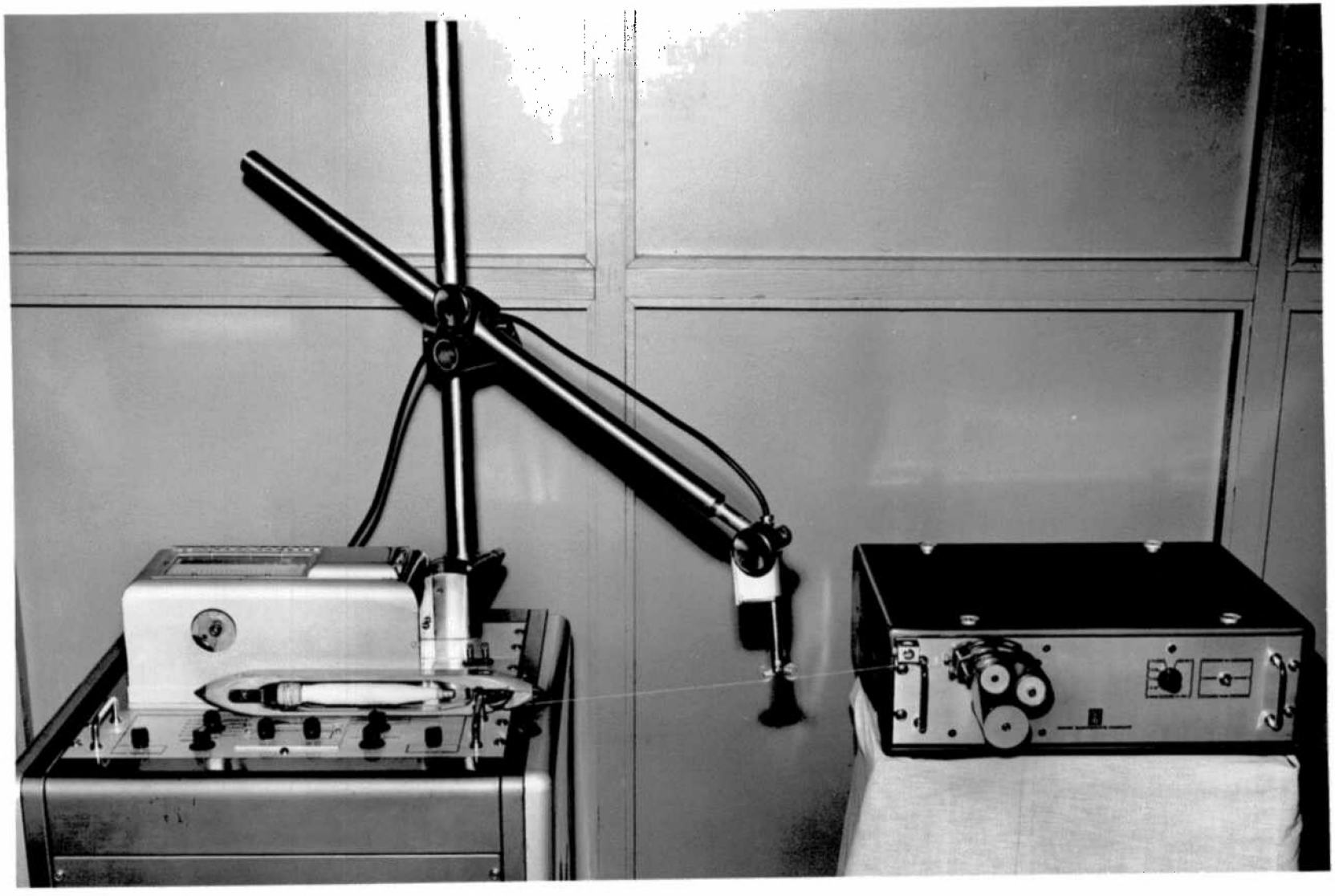
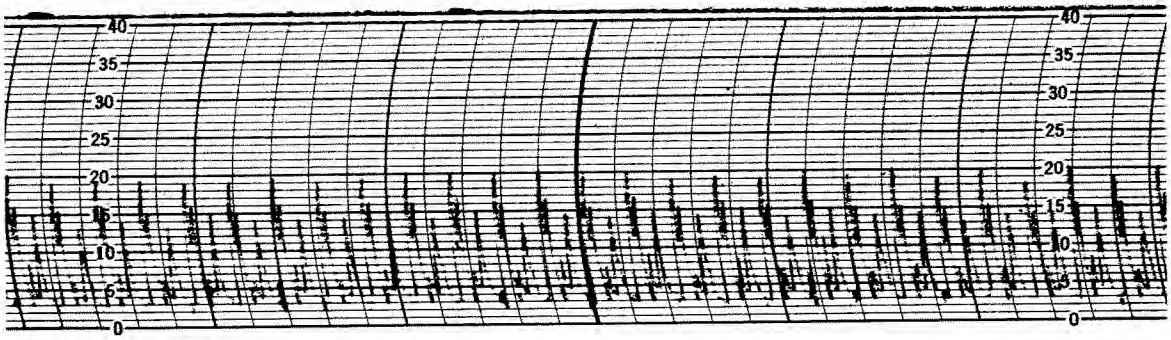
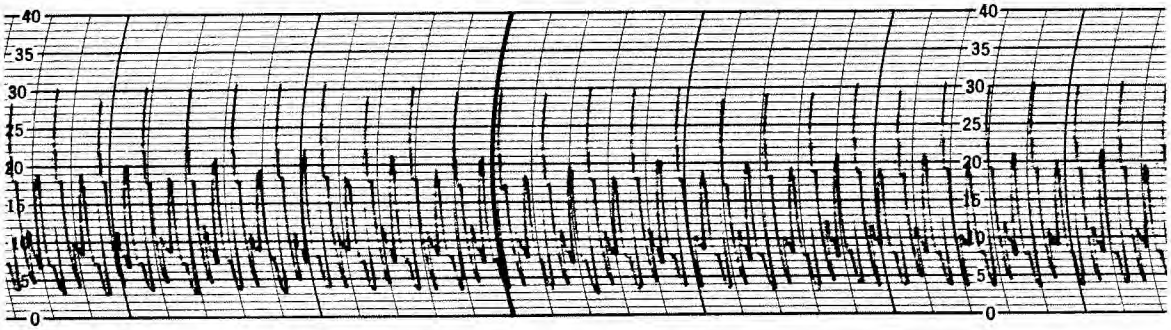


Figure 2. Brush Tension Analyzer Recording Filling Tension

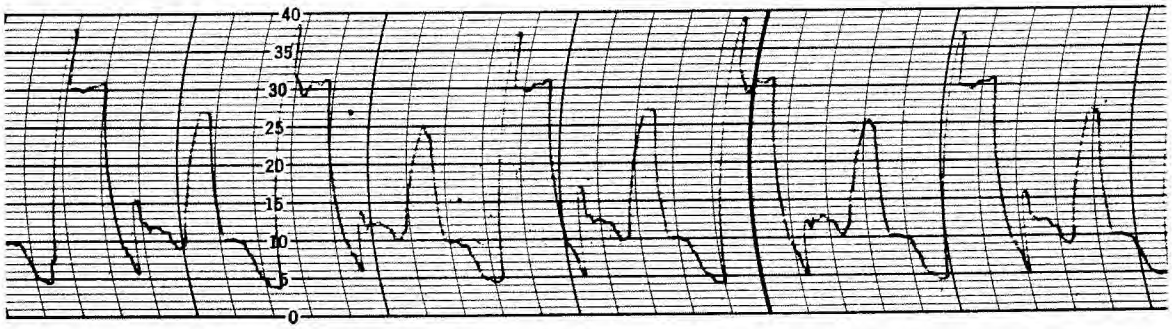
WARP TENSIONS



Tension Chart, 40 Grams Maximum Tension Chart
Slow Speed, 2 Grams Per Chart Line



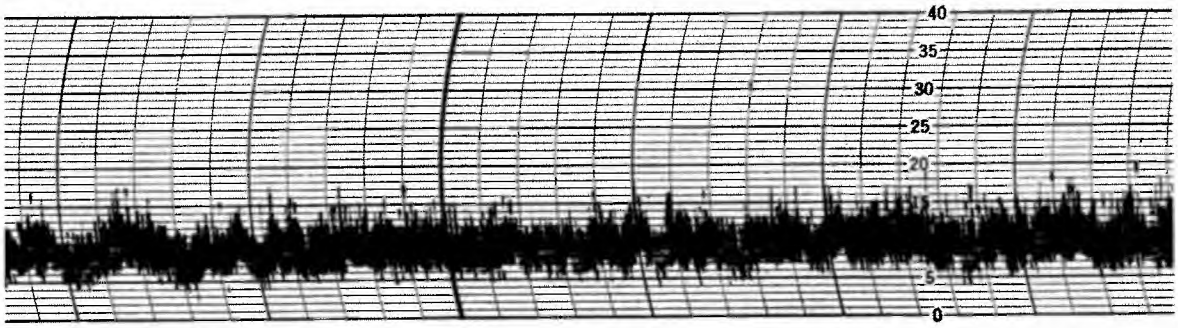
Tension Chart, 60 Grams Maximum Tension Chart
Slow Speed, 2 Grams Per Chart Line



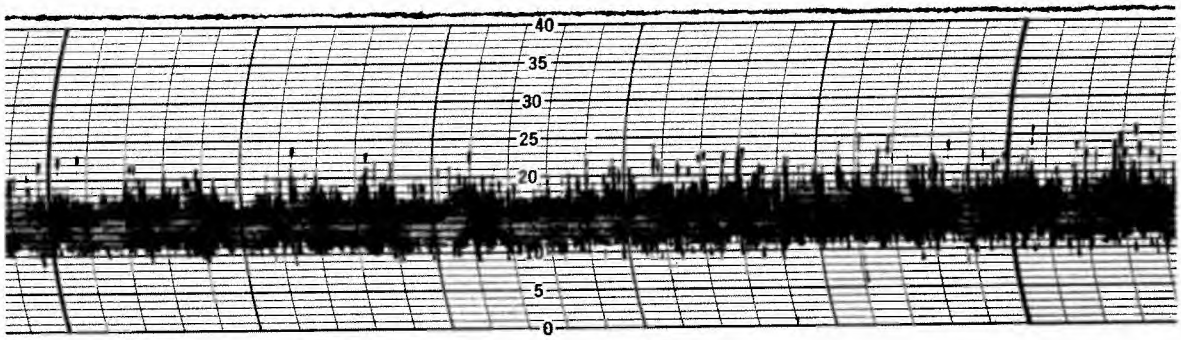
Tension Chart, 80 Grams Maximum Tension Chart
Slow Speed, 2 Grams Per Chart Line

Figure 3. Brush Tension Analyzers Record of Warp Tension

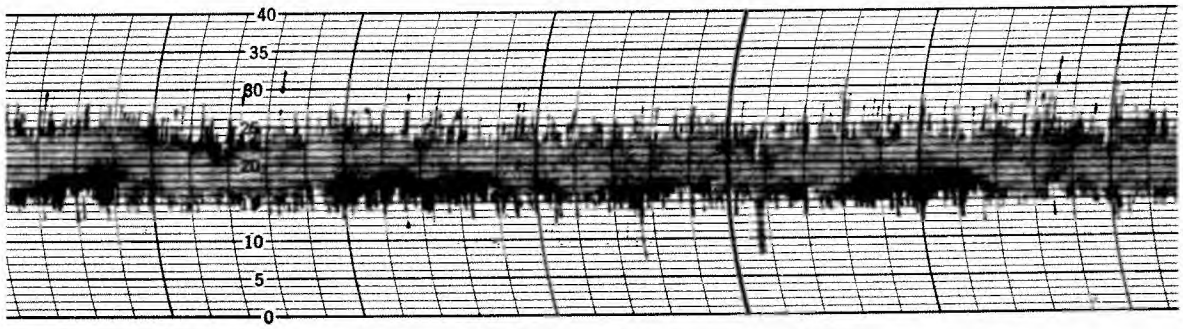
SHUTTLE TENSIONS



Tension Chart, 20 Grams Maximum Tension
Chart Slow Speed, 2 Grams Per Chart Line



Tension Chart, 30 Grams Maximum Tension
Chart Slow Speed, 2 Grams Per Chart Line



Tension Chart, 40 Grams Maximum Tension
Chart Slow Speed, 2 Grams Per Chart Line

Figure 4. Brush Tension Analyzers Recording of Filling Tension

Strength and elongation tests on strips of the fabric were determined using a Scott Vertical Tester. Tensilgrams were used for recording and evaluated later.

The Brighton Crimp Tester was used to determine the crimp. The resulting readings seem a little high but a relative comparison still exists. This tester is not being manufactured at the present time.

Other miscellaneous equipment consists of marking rule for sanforized samples, micrometer (pick glass), Smith-Drum Washer, flat-bed press, templates, and grain balances.

CHAPTER III

PROCEDURE

The warp and filling for this study were furnished by Avondale Mills, Sylacauga, Alabama. The same yarns were used in both warp and filling with the warp yarn having a 12% size added. These yarns were 12.7^{s} count and of medium quality, since they were to be used in a sports denim. By using a standard mill warp producing a standard mill fabric, many of the problems of sanforization were overcome.

Even though the shuttle is at rest before the shed closes on the pick, it was decided to vary both the warp and filling tensions during this study. Three levels of warp and filling tensions were established by actual running. The tensions decided were not extreme in either direction for the type of fabric being produced. In determining these tensions, it was found that extremes in either warp or filling tensions affected the appearance of the cloth. Due to the irregularity of the filling, it would break at the friction pad if too much tension was applied. The following tensions were adopted:

Warp ——————40, 60, and 80 grams.

Filling ——12, 24, and 36 grams.

Since fabrics were to be produced to be tested both in the greige and sanforized state, it was decided to run the greige samples first. Ten yards of each of the greige samples were run at the following tensions:

Sample 1 —— Warp 40 grams —— Filling 12 grams

Sample 2 —— Warp 60 grams —— Filling 12 grams

Sample 3 —— Warp 80 grams —— Filling 12 grams

Sample 4 —— Warp 40 grams —— Filling 24 grams

Sample 5 —— Warp 60 grams —— Filling 24 grams

Sample 6 —— Warp 80 grams —— Filling 24 grams

Sample 7 —— Warp 40 grams —— Filling 36 grams

Sample 8 —— Warp 60 grams —— Filling 36 grams

Sample 9 —— Warp 80 grams —— Filling 36 grams

The tension was adjusted on the shuttle by using the adjustable friction pads in the eye. One group of bristles were placed in the shuttle close to the end of the quill to facilitate the threading of the eye on the change. The Brush Electronics Tension Analyzer was used to adjust the tension on the shuttle. An illustration of this being accomplished is shown on page 9. The warp tension was also adjusted using this instrument and an illustration of this is shown on page 8. During the running of each sample, the shuttle was removed and the tension checked. The warp tension was checked at least twice per hour. An example of the charts made by the Brush Electronics Tension Analyzer during the warp and filling tension adjustment are shown on pages 10 and 11.

Prior to starting the production run, the loom was adjusted with the assistance of the Tension Analyzer. Some of these adjustments in which the Analyzer was useful were the uniformity of the Bartlett let-off, height of drop wire bars, whiproll height and timing, and harness opening and timing. Tests were made to determine how often the individual warp

ends, scattered across the width of the warp, should be checked. This was necessary because the Tension Analyzer recorded the tension of only one end. It was found that very little variation existed from end to end; therefore, very little changing was done while running a sample. All production samples were run with a temperature of 80° and a humidity of 75%.

After the completion of the production of the greige samples, nine additional samples were produced. These samples were produced under duplicate conditions as those for greige testing except that they were twenty-five yards long. The longer length was decided on for these samples so as to give them more freedom of action, if needed, while they were being sanforized. All nine samples were produced in a continuous length, total two hundred twenty-five yards, and were sanforized in this state. The same shrinkage setting on the sanforizer was used for the complete piece of goods. An attempt was made to set the shrinkage on the basis of the sample showing the least shrinkage. This did not work out, however, as some of the fabric was overshrunk. Further reference is made to this point later.

After all samples were produced, testing samples were cut. Each sample was divided into three subsamples, namely A, B, and C. From each of the subsamples, testing samples were prepared as follows:

Shrinkage test samples

Strip test samples

4" x 6" samples for weighing

Analysis sample (Construction and Crimp)

This same procedure was followed for both greige and sanforized.

At the time of cutting the testing samples, the width was measured to the nearest 16th inch at five points throughout each sample. These reading were converted to decimals and recorded.

The construction of each sample was checked at three different points on each subsample giving nine readings for each sample. No readings were taken closer than 4" from the selvage. A micrometer pick glass was used for taking the readings.

Five samples 4 in. by 6 in. were cut, using a template, from each subsample. These samples were weighed on balances to the nearest thousandth of a grain. The average of these readings was computed and using this figure, yards per pound were determined for each sample based on actual width.

In determining the crimp in the yarn a piece was taken from each subsample and raveled to a straight edge both warp and filling-wise. Markings were made on the fabric eight inches apart. Five ends of each warp and filling were removed and checked for crimp on the Brighton Crimp Meter. The instrument was weighted with 12.7 grams. The amount of this weight was determined as follows:

$$\frac{131 \times 1000}{12.7 \times 840} = 12.7 \text{ grams}$$

Care was taken to preserve the twist in the yarn as the crimp was checked.

Shrinkage samples were prepared by cutting a twenty-four inch sample from each subsample. These samples were marked for identification and cut about $\frac{1}{2}$" in along each edge. This cutting helps to prevent tangling of loose threads. The samples were then marked at five places, both warp

and filling-wise 18" apart. Samples were then placed in a Smith-Drum Washer. The water was heated to 140°F and the soap added. The temperature of the water was then raised to 210° and the samples were washed for 40 minutes. At this time the water was drained and the washer refilled and heated to 140° and the washer was run for 10 minutes. The water was then drained and refilled and heated to 140° and run for 5 minutes. The washer was then drained and the samples allowed to tumble for 5 minutes before removing for drying. The samples were dried flat, sprinkled damp and pressed on a flat bed press. The original markings on the fabrics were again measured and the results recorded.

Strips were prepared for the breaking strength and elongation test. Six strips were prepared 1½ in. by 6 in. with the long way of the sample warp-wise and six strips filling-wise from each of the subsamples. These strips were raveled until they were 1" wide. The samples were then broken on a Scott Vertical Tester and the results plotted on tensilgrams. The jaws on the machine were set 3" apart and the speed of travel was 12" per minute. After all samples were broken, the tensilgrams were evaluated and results were summarized.

To check the effect on bow in the fabric, colored filling bars were run at intervals. Three bars were run in at three levels of warp tension, 40 grams, 60 grams, and 80 grams. A medium filling tension was used for this test. The per cent bow was computed on the actual width at that point.

CHAPTER IV

RESULTS

The results obtained from testing the samples are given for both the greige and sanforized under the same group heading.

Effects on Fabric Width.—Below are tables showing a summary of the results of measuring fabric width.

Table 1. Summary of Effects of Tension on Greige Widths

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Width (inches)
1	40	12	44.713
2	60	12	44.438
3	80	12	44.075
4	40	24	44.613
5	60	24	44.288
6	80	24	44.109
7	40	36	44.650
8	60	36	44.300
9	80	36	44.000

In the above table it can be seen that there is a definite tendency for the fabric to narrow as the warp tension is increased. Group 1, 2, and 3 with a progressive increase in warp tension using the same filling

tension narrowed .638" or 1.43%. The other groups had a similar effect. The changes in filling tension did not seem to vary the results to any extent.

Table 2 shows the results obtained with the sanforized fabrics. An examination of these results indicate the opposite effect from that in the greige. A good example is samples 4, 5, and 6 with an increase in width of .438" or .98%. The effect of filling tension was not too definite.

Table 2. Summary of Effects of Tension on Sanforized Widths

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Width (inches)
1	40	12	41.683
2	60	12	41.787
3	80	12	41.787
4	40	24	41.562
5	60	24	41.812
6	80	24	42.000
7	40	36	41.537
8	60	36	41.599
9	80	36	41.662

Effects on Construction.--The tension on the warp has some effect on the picks per inch and since it affects the width of the fabric it does seem to affect the ends per inch. Table 3 gives a summary of the effects on the greige fabric and Table 4 a summary of the effects on the sanforized fabric.

It appears that due to the fabric's being woven under greater tension, there is probably more contraction of the fabric after it is removed from the loom. This should also affect the crimp of the two systems.

In the sanforized fabric, the results were not too conclusive. However, it can be seen in Table 4 that the ends per inch decreased slightly as the tension was increased. The pickage indication was much more definite as the picks per inch increased as much as 6.71% in the group 7, 8, and 9.

Table 3. Summary of Effects of Tension on Greige Constructions

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Ends Per Inch	Picks Per Inch
1	40	12	61.6	41.2
2	60	12	61.8	41.0
3	80	12	62.2	41.7
4	40	24	61.5	40.8
5	60	24	61.9	41.4
6	80	24	62.0	42.8
7	40	36	61.5	41.5
8	60	36	61.8	41.5
9	80	36	62.5	43.0

Table 4. Summary of Effects of Tension on Sanforized Constructions

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Ends Per Inch	Picks Per Inch
1	40	12	66.4	43.2
2	60	12	66.2	43.9

(continued)

Table 4. Summary of Effects of Tension on Sanforized Constructions (continued)

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Ends Per Inch	Picks Per Inch
3	80	12	66.2	44.8
4	40	24	66.3	42.6
5	60	24	65.1	44.2
6	80	24	65.9	45.8
7	40	36	65.8	43.2
8	60	36	66.1	43.9
9	80	36	65.9	46.1

Effects on Yards Per Pound.---The results of the fabric weight appear a bit confusing and are not too conclusive. As the tension on the warp was increased, all three groups showed that the fabric became lighter in weight. This means that the yards per pound increased as the tension on the warp increased. Table 5 shows a summary of the results of the nine samples.

Table 5. Summary of Effects of Tension on Greige Yards Per Pound

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Weight 4" x 6" (grains)	Yards Per Pound
1	40	12	46.428	2.248
2	60	12	46.407	2.263
3	80	12	46.362	2.284
4	40	24	46.465	2.251
5	60	24	46.454	2.268
6	80	24	46.437	2.278

(continued)

Table 5. Summary of Effects of Tension on Greige Yards Per Pound (continued)

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Weight 4" x 6" (grains)	Yards Per Pound
7	40	36	46.459	2.250
8	60	36	46.442	2.268
9	80	36	46.435	2.284

In computing the yards per pound the actual width of the sample was used. These widths came from Table 1. It seems that there is less warp length in the fabric woven under greater warp tension, which probably accounts for the weight per yard being decreased. This also can be seen later in the crimp results in Table 7. The increase in pickage is more than offset by the stretching of the warp.

After the fabric was sanforized, it was found that the fabric which was made under the greatest tension was the heavier. As the weaving tensions were increased, the sanforized fabric was heavier in all groups. In Table 6 one can see that the weights of the 4 in. by 6 in. samples increased.

Due to the fabric's being woven under greater tension and the warp's being in a stretched condition, there is more relaxation for the warp to do. This relaxation causes the fabric woven under the greater tension to relax more, thereby giving an increased weight to the fabric. There seems to be no definite trend in regard to filling tension.

Table 6. Summary of Effects of Tension on Sanforized Yards Per Pound

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Weight 4" x 6" (grains)	Yards Per Pound
1	40	12	55.269	2.026
2	60	12	55.344	2.018
3	80	12	55.358	2.017
4	40	24	55.238	2.033
5	60	24	55.370	2.017
6	80	24	55.411	2.005
7	40	36	55.267	2.033
8	60	36	55.320	2.028
9	80	36	55.405	2.022

Effects on Crimp.—Table 7 below shows a summary of the results on crimp in both the warp and filling. It is apparent that the per cent crimp in the warp decreased as the woven tension increased. The heavy tension on the warp at the time of interlacing with the filling also affects the crimp in the filling. The harder it is for the warp to bend, the more the filling is crimped. As the warp crimp decreases, the filling crimp is increased. This was proven true in all groups.

In the sanforized fabric the results were in the opposite direction. After the shrinking of the fabric by sanforization, the samples woven the greatest tension seemed to have the most crimp in the warp. As the warp crimp increased, the filling crimp decreased. These results were not too surprising if one will review the results on construction, width, and yards per pound. If one thinks of weaving a warp end under a heavy tension and stretching it to a great extent, then shrinking the fabric, which

is going to increase the crimp in the yarn, one would expect it to bend more around the filling. In this case the filling would probably be less crimped. These results can be seen in Table 8.

Table 7. Summary of Effects of Tension on Greige Crimp

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Warp Crimp	Filling Crimp
1	40	12	11.105%	5.980%
2	60	12	9.833%	6.080%
3	80	12	8.293%	7.127%
4	40	24	13.353%	5.487%
5	60	24	11.013%	6.287%
6	80	24	9.227%	6.733%
7	40	36	12.713%	5.500%
8	60	36	11.333%	5.960%
9	80	36	9.353%	6.547%

Table 8. Summary of Effects of Tension on Sanforized Crimp

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Warp Crimp	Filling Crimp
1	40	12	14.53%	11.76%
2	60	12	15.00%	11.43%
3	80	12	15.69%	11.07%
4	40	24	13.82%	11.64%
5	60	24	15.63%	11.21%
6	80	24	15.80%	9.90%
7	40	36	14.71%	11.11%
8	60	36	15.45%	11.21%
9	80	36	15.73%	10.91%

Effects on Shrinkage Characteristics.—In looking at the results of greige shrinkage Table 9, it is evident that as the woven tension increased, the relaxation shrinkage also increased warp-wise. Filling-wise, the opposite was true. Since the warp yarns were under more tension while being interlaced, they were also under more strain in the woven fabric. Washing the fabric allowed these yarns to relax, thus relieving themselves of some of their strain. From the above statements one would expect more relaxation shrinkage at the higher woven tensions. It should be kept in mind that during this washing, there is no control over any of the yarns in the system. This is probably the reason for the decrease in filling shrinkage as the woven tension increased.

Table 9. Summary of Effects of Tension on Greige Shrinkage

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Warp-Wise Shrinkage (%)	Filling-Wise Shrinkage (%)
1	40	12	12.33	5.22
2	60	12	12.89	5.11
3	80	12	13.00	5.06
4	40	24	10.22	4.72
5	60	24	11.22	4.39
6	80	24	11.61	4.22
7	40	36	10.89	5.61
8	60	36	11.61	4.83
9	80	36	11.72	4.78

The sanforized samples were tested in the same manner as the greige. One must keep in mind that the sanforizing process is a

mechanical compressive shrinkage. This process forces the warp to take a given length while the width is being held approximately constant. When the fabric is again wet-out, or washed without any mechanical control, the yarns have a better chance to relax. In Table 10 we have a summary of the results of the wash test on the sanforized samples.

Table 10. Summary of Effects of Tension on Sanforized Shrinkage

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Warp-Wise Shrinkage (%)	Filling-Wise Shrinkage (%)
1	40	12	1.22	.77
2	60	12	1.00	.94
3	80	12	1.11	.92
4	40	24	.16	1.00
5	60	24	.61	1.22
6	80	24	.66	1.00
7	40	36	.66	1.16
8	60	36	.78	1.22
9	80	36	1.38	1.11

The table shows that the fabric was overshrunk during the sanforizing process; however, the figures are still comparative. There seems to be an indication in the results that as there was more residual shrinkage left in the filling, there was less overshrinking of the warp. We can certainly see that the variation of warp tension has its effect even on the sanforized fabric. In the second two groups - 4, 5, 6, and 7, 8, 9, - a progressive change in the warp shrinkage is noted.

In Table 11 it can be seen that as the tensions were increased, there was a lowering of the breaking strength. This seemed to be true both warp and filling-wise. The elongation in the warp decreased as the breaking strength decreased; however, the effect filling-wise was opposite. The strength of a fabric depends not only on the yarn from which it is made but also on the ability of those yarns to rearrange themselves so that the breaking strain will be distributed among all yarns in the fabric. As the yarns in the direction of breaking are allowed to straighten out, their strength will more nearly approach the combined strength of the yarns.

Table 11. Summary of Effects of Tension on Greige Breaking Strength and Elongation Ravel Strip, Jaws Set 3" Apart

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Warp Break (lbs.)	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (%)
1	40	12	87.9	20.3	60.5	12.7
2	60	12	87.5	18.8	59.2	13.2
3	80	12	87.5	15.7	56.9	12.2
4	40	24	86.5	22.8	62.1	11.8
5	60	24	86.8	18.4	59.8	12.6
6	80	24	84.4	16.9	57.9	13.1
7	40	36	85.9	21.8	60.5	11.8
8	60	36	85.6	19.3	56.1	12.5
9	80	36	84.8	18.4	54.3	12.7

Table 12. Summary of Effects of Tension on Sanforized Breaking Strength and Elongation Ravel Strip, Jaws Set 3" Apart

Sample Number	Warp Tension (grams)	Filling Tension (grams)	Warp Break (lbs.)	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (%)
1	40	12	86.7	25.0	62.9	20.3
2	60	12	92.9	28.0	62.4	21.9
3	80	12	93.2	26.4	63.7	20.0
4	40	24	92.9	27.1	63.5	21.7
5	60	24	89.5	25.5	64.9	19.5
6	80	24	91.3	26.2	64.7	20.3
7	40	36	85.9	27.2	61.2	21.5
8	60	36	88.0	28.8	64.8	21.6
9	80	36	88.4	26.7	66.3	21.5

In the sanforized fabric, the effect was in the opposite direction. As the woven tension was increased, the warp and filling breaking strength were increased. This was also accompanied by increased elongation in the warp and decreased elongation in the filling. If one refers to Table 10, there can be seen a relationship of this change in elongation to the residual shrinkage. The summary of breaking strength and elongation is shown in Table 12.

The results of the bow test using a filling tension of 24 grams and changing the warp tension were as follows:

Warp Tension: 40 grams ----- Bow 1.47%

Warp Tension: 60 grams ----- Bow 1.66%

Warp Tension: 80 grams ----- Bow 2.29%

As the warp tension increased, the per cent bow was also increased.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The results of the tests on fabrics woven at different tensions show that yarn tensioning during weaving definitely affects the characteristics of the fabric in the greige and in the sanforized state. These tensions contribute to the non-uniformity of fabrics in any given type of fabric. Their effects seem to be widespread and not associated with just one characteristic. It seems that it would be impossible to expect to finish fabrics to the same width, with the same residual shrinkage, and with a uniform yards per pound unless the conditions under which these fabrics were produced were uniform from loom to loom. Some of the conclusions arrived at as a result of this study are given below.

Effects of Weaving Tensions on Greige Fabrics.--

1. As the tension on the warp is increased, the width decreases.

2. As the tension on the warp is increased, the construction increases both warp and filling-wise.

3. As the tension on the warp is increased, the weight per yard decreases and the yards per pound increase.

4. As the tension on the warp is increased, the warp crimp decreases and filling crimp increases.

5. As the tension on the warp is increased, the shrinkage warp-wise increases and the shrinkage filling-wise decreases.

6. As the tension on the warp is increased, the breaking strength of the fabric is decreased both warp and filling-wise.

7. The effects of increasing the tension as it is drawn from the shuttle seem to be slight.

Effects of Weaving Tensions on Sanforized Fabric.--

1. As the tension on the warp is increased, the sanforized width is increased.

2. As the tension on the warp is increased, the sley is slightly decreased and the picks per inch increases.

3. As the tension on the warp is increased, the weight per yard increases and the yards per pound decreases.

4. As the tension on the warp is increased, the warp crimp is increased and the filling crimp is decreased.

5. As the tension on the warp is increased, the shrinkage in the direction of the warp is increased and seems to have little effect on the fabric filling-wise.

6. As the tension on the warp is increased, the breaking strength seems to be increased both warp and filling-wise.

7. The effects of increasing the tension on the filling as it is drawn from the shuttle seem to be slight.

It is quite interesting to note that some of the effects are reversed in the sanforized fabric from those in the greige. This seems to be due to the additional strain the yarns are under in the fabric. These strains are released up to a point upon sanforization and in some cases actually placed into the yarns in reverse.

This study only covered one fabric. There is every reason to believe that different results might be obtained in fabrics woven other than the sports denim three harness twill. Variations in yarn counts and heavy construction would certainly have varying effects on fabric characteristics. It would be enlightening to carry this study further and compare the effects due to yarns and constructions.

A P P E M D I X

Table 13. Effects of Tension on Greige Widths

(Measured to Nearest 16th Inch and Converted to Decimals)

Sample 1:	44.688 in.	Sample 2:	44.500 in.	Sample 3:	44.062 in.
	.750 in.		.438 in.		.062 in.
	.750 in.		.438 in.		.130 in.
	.688 in.		.375 in.		.063 in.
	.688 in.		.438 in.		.063 in.
	44.713 in.		44.438 in.		44.075 in.
Sample 4:	44.625 in.	Sample 5:	44.250 in.	Sample 6:	44.125 in.
	.563 in.		.313 in.		.006 in.
	.625 in.		.313 in.		.063 in.
	.625 in.		.250 in.		.187 in.
	.625 in.		.313 in.		.063 in.
	44.613 in.		44.288 in.		44.109 in.
Sample 7:	44.625 in.	Sample 8:	44.250 in.	Sample 9:	43.875 in.
	.688 in.		.375 in.		.000 in.
	.688 in.		.313 in.		.000 in.
	.625 in.		.250 in.		.063 in.
	.625 in.		.313 in.		.062 in.
	44.650 in.		44.300 in.		44.000 in.

Table 14. Effects of Tension on Sanforized Widths

(Measured to Nearest 16th Inch and Converted to Decimals)

Sample 1:	41.687 in.	Sample 2:	41.875 in.	Sample 3:	41.812 in.
	41.750 in.		41.687 in.		41.812 in.
	41.687 in.		41.812 in.		41.750 in.
	41.602 in.		41.750 in.		41.812 in.
	41.687 in.		41.812 in.		41.750 in.
	41.683 in.		41.787 in.		41.787 in.
Sample 4:	41.500 in.	Sample 5:	42.000 in.	Sample 6:	41.937 in.
	41.562 in.		41.875 in.		42.000 in.
	41.562 in.		41.750 in.		42.000 in.
	41.625 in.		41.750 in.		42.000 in.
	41.562 in.		41.678 in.		42.062 in.
	41.562 in.		41.812 in.		42.000 in.
Sample 7:	41.437 in.	Sample 8:	41.537 in.	Sample 9:	41.625 in.
	41.562 in.		41.600 in.		41.750 in.
	41.625 in.		41.600 in.		41.687 in.
	41.562 in.		41.662 in.		41.687 in.
	41.500 in.		41.600 in.		41.562 in.
	41.537 in.		41.599 in.		41.662 in.

Table 15. Effects of Tension on Creige Construction

Sample 1

Tension, Warp 40 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
61.4	41.0	62.0	41.2	62.0	42.0
61.5	41.0	61.8	41.0	61.1	40.5
61.4	41.6	61.2	41.2	62.0	41.2
61.4	41.2	61.7	41.1	61.7	41.2

Average: Warp 61.6 Filling 41.2

Sample 2

Tension, Warp 60 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
61.9	40.1	61.8	41.1	62.0	41.3
61.5	41.8	61.8	41.1	61.8	40.8
62.0	41.4	61.8	40.8	61.7	40.5
61.8	41.1	61.8	41.0	61.8	40.9

Average: Warp 61.8 Filling 41.0

Sample 3

Tension, Warp 80 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
62.2	42.8	62.6	42.0	62.3	41.5
62.3	42.7	62.0	41.3	62.0	41.2
62.0	41.0	62.0	41.0	62.0	41.5
62.2	42.2	62.2	41.4	62.1	41.4

Average: Warp 62.2 Filling 41.7

(continued)

Table 15. Effects of Tension on Greige Construction
(continued)

Sample 4

Tension, Warp 40 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
61.5	41.4	61.5	49.0	61.5	40.7
61.5	41.4	61.4	48.0	62.0	40.5
61.4	40.3	61.5	47.0	61.4	40.8
61.5	41.0	61.5	48.0	61.6	40.7

Average: Warp 61.5 Filling 40.8

Sample 5

Tension, Warp 60 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
61.8	42.0	61.8	42.3	62.0	41.0
61.6	41.6	62.0	41.6	62.0	41.2
62.0	41.5	62.0	41.0	61.8	40.7
61.8	41.7	62.0	41.6	62.0	41.0

Average: Warp 61.9 Filling 41.4

Sample 6

Tension, Warp 80 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
62.0	43.0	63.0	42.5	62.0	42.5
62.2	42.0	62.0	44.0	62.5	43.3
61.8	42.0	62.2	43.2	62.0	43.4
62.0	42.3	62.4	43.2	62.2	43.1

Average: Warp 62.0 Filling 42.8

(continued)

Table 15. Effects of Tension on Greige Construction
(continued)

Sample 7

Tension, Warp 40 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
61.5	42.0	61.8	41.2	61.6	41.0
61.6	42.0	62.0	41.5	61.5	41.1
61.2	41.4	61.6	41.9	61.5	41.1
61.4	41.8	61.8	41.6	61.5	41.1

Average: Warp 61.5 Filling 41.5

Sample 8

Tension, Warp 60 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
62.0	40.7	62.0	41.6	62.0	41.0
62.0	41.5	62.0	41.6	62.0	41.9
61.5	42.0	61.5	41.3	61.6	41.9
61.8	41.4	61.8	41.5	61.8	41.6

Average: Warp 61.8 Filling 41.5

Sample 9

Tension, Warp 80 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
63.0	45.0	63.0	43.0	62.5	43.0
63.0	42.5	62.5	43.0	63.0	43.5
63.0	43.5	62.5	43.0	62.5	42.5
63.0	43.6	62.7	43.0	62.7	43.0

Average: Warp 62.5 Filling 43.0

Table 16. Effects of Tension on Sanforized Construction

Sample 1

Tension, Warp 40 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
67.0	44.0	66.0	44.0	66.5	43.5
66.0	42.6	66.5	43.0	67.0	43.0
66.0	43.0	66.5	42.7	66.5	43.4
66.3	43.2	66.3	43.2	66.6	43.3

Average: Warp 66.4 Filling 43.2

Sample 2

Tension, Warp 60 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
66.0	44.0	66.0	44.5	66.0	44.5
66.0	43.8	66.0	43.6	66.0	43.8
67.0	44.0	66.0	43.7	67.0	43.5
66.3	43.9	66.0	43.9	66.3	43.9

Average: Warp 66.2 Filling 43.9

Sample 3

Tension, Warp 80 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
65.6	44.3	66.0	45.0	66.0	45.0
66.0	45.0	65.8	45.0	66.0	45.5
67.0	44.8	67.0	44.5	66.5	44.0
66.2	44.7	66.3	44.8	66.2	44.8

Average: Warp 66.2 Filling 44.8

(continued)

Table 16. Effects of Tension on Sanforized Construction
(continued)

Sample 4

Tension, Warp 40 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
66.0	42.2	66.0	42.0	66.0	42.2
66.5	43.0	67.0	42.8	66.8	42.8
66.5	43.0	66.0	43.0	66.3	42.8
66.3	42.7	66.3	42.6	66.4	42.6

Average: Warp 66.3 Filling 42.6

Sample 5

Tension, Warp 60 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
65.0	44.0	65.2	44.2	65.0	44.0
65.3	44.5	65.0	44.0	65.2	44.2
65.1	44.5	65.0	44.6	65.0	44.0
65.1	44.3	65.1	44.3	65.1	44.1

Average: Warp 65.1 Filling 44.2

Sample 6

Tension, Warp 80 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
66.0	46.0	65.8	45.8	66.0	46.0
66.0	46.0	66.0	45.6	66.0	45.8
65.5	45.5	66.0	46.0	66.2	45.6
65.8	45.8	65.9	45.8	66.1	45.8

Average: Warp 65.9 Filling 45.8

(continued)

Table 16. Effects of Tension on Sanforized Construction (continued)

Sample 7

Tension, Warp 40 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
65.8	43.1	65.8	43.0	66.0	43.3
66.0	43.1	66.0	43.0	66.0	43.0
65.5	43.4	65.8	43.5	65.5	43.3
65.8	43.2	65.8	43.2	65.8	43.2

Average: Warp 65.8 Filling 43.2

Sample 8

Tension, Warp 60 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
66.2	44.0	66.0	44.1	66.0	44.1
66.0	43.8	66.0	44.0	66.0	44.0
66.4	43.8	66.0	43.6	66.0	43.6
66.2	43.9	66.0	43.9	66.0	43.9

Average: Warp 66.1 Filling 43.9

Sample 9

Tension, Warp 80 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
66.2	46.0	66.1	46.2	66.0	46.0
65.8	46.0	66.0	46.2	65.8	46.0
65.6	46.0	66.0	45.6	65.8	46.2
65.9	46.0	66.0	46.1	65.9	46.1

Average: Warp 65.9 Filling 46.1

Table 17. Effects of Tension on Greige Yards Per Pound
4" x 6" Sample

Sample 1

Tension: Warp 40 grams, Filling 12 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
46.385	46.432	46.512		
.363	.419	.514		
.398	.372	.441		
.400	.393	.461		
.490	.418	.424		
46.407	46.407	46.470	46.428	2.248

Sample 2

Tension: Warp 60 grams, Filling 12 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
46.405	46.388	46.256		
.397	.393	.276		
.422	.492	.428		
.443	.492	.363		
.543	.408	.416		
46.405	46.431	46.348	46.407	2.263

Sample 3

Tension: Warp 80 grams, Filling 12 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
46.333	46.422	46.406		
.342	.450	.362		
.277	.433	.389		
.271	.370	.393		
.264	.255	.463		
46.297	46.386	46.402	46.362	2.284

(continued)

Table 17. Effects of Tension on Greige Yards Per Pound
4" x 6" Sample (continued)

Sample 4

Tension: Warp 40 grams, Filling 24 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
46.586	46.388	46.519		
.568	.366	.561		
.515	.342	.472		
.466	.405	.493		
.482	.347	.466		
46.523	46.370	46.502	46.465	2.251

Sample 5

Tension: Warp 60 grams, Filling 24 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
46.436	46.489	46.385		
.482	.501	.404		
.453	.452	.389		
.450	.519	.408		
.499	.516	.438		
46.464	46.495	46.405	46.454	2.268

Sample 6

Tension: Warp 80 grams, Filling 24 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
46.389	46.422	46.456		
.412	.445	.479		
.327	.462	.501		
.333	.510	.484		
.299	.500	.473		
46.364	46.468	46.478	46.437	2.278

(continued)

Table 17. Effects of Tension on Greige Yards Per Pound
4" x 6" Sample (continued)

Sample 7

Tension: Warp 40 grams, Filling 36 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
46.487	46.427	46.418		
.458	.450	.434		
.483	.423	.535		
.465	.449	.515		
.468	.424	.452		
46.472	46.435	46.471	46.459	2.250

Sample 8

Tension: Warp 60 grams, Filling 36 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
46.362	46.532	46.501		
.358	.539	.521		
.354	.513	.455		
.350	.543	.441		
.282	.436	.468		
46.341	46.512	46.474	46.442	2.268

Sample 9

Tension: Warp 80 grams, Filling 36 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
46.515	46.575	46.348		
.554	.475	.307		
.532	.463	.256		
.428	.482	.328		
.478	.462	.326		
46.501	46.491	46.313	46.435	2.284

*Based on actual width table.

Table 18. Effects of Tension on Sanforized Yards Per Pound
4" x 6" Sample

Sample 1

Tension: Warp 40 grams, Filling 12 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
55.294	55.330	55.190		
.282	.360	.260		
.230	.331	.192		
.258	.370	.240		
.167	.350	.187		
55.246	55.348	55.214	55.269	2.026

Sample 2

Tension: Warp 60 grams, Filling 12 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
55.307	55.428	55.355		
.317	.300	.329		
.350	.368	.287		
.297	.401	.392		
.285	.419	.329		
55.311	55.383	55.338	55.344	2.018

Sample 3

Tension: Warp 80 grams, Filling 12 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
55.295	55.352	55.298		
.312	.472	.315		
.336	.462	.350		
.345	.420	.348		
.328	.400	.338		
55.323	55.421	55.330	55.358	2.017

(continued)

Table 18. Effects of Tension on Sanforized Yards Per Pound
4" x 6" Sample (continued)

Sample 4

Tension: Warp 40 grams, Filling 24 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
55.050	55.458	55.214		
.062	.378	.328		
.148	.332	.302		
.106	.284	.223		
.153	.318	.210		
55.104	55.354	55.255	55.238	2.033

Sample 5

Tension: Warp 60 grams, Filling 24 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
55.462	55.249	55.400		
.546	.270	.405		
.510	.258	.375		
.310	.270	.452		
.369	.255	.425		
55.439	55.260	55.411	55.370	2.017

Sample 6

Tension: Warp 60 grams, Filling 24 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
55.375	55.411	55.372		
.425	.475	.415		
.434	.415	.418		
.400	.405	.389		
.412	.425	.395		
55.409	55.426	55.398	55.411	2.005

(continued)

Table 18. Effects of Tension on Sanforized Yards Per Pound
4" x 6" Sample (continued)

Sample 7

Tension: Warp 40 grams, Filling 36 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
55.315	55.267	55.185		
.295	.244	.172		
.301	.178	.401		
.244	.249	.370		
.250	.272	.269		
55.281	55.242	55.279	55.267	2.033

Sample 8

Tension: Warp 60 grams, Filling 36 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
55.323	55.360	55.332		
.327	.335	.378		
.247	.201	.408		
.222	.232	.383		
.393	.219	.438		
55.302	55.269	55.388	55.320	2.028

Sample 9

Tension: Warp 80 grams, Filling 36 grams

A Weight (Gr.)	B Weight (Gr.)	C Weight (Gr.)	Average Weight (Gr.)	Yards Per Pound*
55.408	55.302	55.413		
.418	.312	.385		
.454	.400	.471		
.476	.392	.450		
.472	.370	.344		
55.445	55.355	55.413	55.405	2.022

*Based on actual width table.

Table 19. Effects of Tension on Greige Crimp Per Cent Using Brighten Crimp Tester

Sample 1

Tension, Warp 40 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
11.2	5.6	12.1	6.3	10.4	6.2
11.1	5.5	12.4	6.2	10.3	5.9
11.2	5.7	11.8	6.2	9.9	6.2
11.2	5.6	12.2	6.2	9.9	6.1
11.1	5.6	12.0	6.3	10.0	6.1
11.116	5.600	12.100	6.240	10.100	6.100

Average: Warp 11.105 Filling 5.980

Sample 2

Tension, Warp 60 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
10.2	6.4	10.4	5.8	9.2	5.9
10.4	6.2	10.0	6.0	8.9	5.8
10.3	6.5	9.8	6.0	9.1	6.0
10.2	6.3	10.4	6.2	9.2	6.0
9.9	6.4	10.2	5.8	9.3	5.9
10.20	6.360	10.160	5.960	9.140	5.920

Average: Warp 9.833 Filling 6.080

Sample 3

Tension, Warp 80 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
8.2	7.0	8.2	7.4	8.6	7.2
7.8	7.2	8.2	7.2	8.8	7.3
7.9	7.0	8.0	7.2	9.0	7.0
8.0	7.0	7.8	7.0	8.8	7.2
8.2	6.8	8.2	7.4	8.7	7.0
8.020	7.000	8.080	7.240	8.780	7.140

Average: Warp 8.293 Filling 7.127

(continued)

Table 19. Effects of Tension on Greige Crimp Per Cent Using Brighton Crimp Tester (continued)

Sample 4

Tension, Warp 40 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
13.6	5.4	12.2	5.6	13.8	5.2
14.0	5.6	12.4	5.8	14.0	5.0
13.8	5.2	12.5	6.2	14.0	5.3
13.9	5.4	12.2	5.8	13.8	5.0
13.6	5.4	12.3	6.2	14.2	5.2
13.780	5.400	12.320	5.920	13.960	5.140

Average: Warp 13.353 Filling 5.487

Sample 5

Tension, Warp 60 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
11.0	5.9	11.2	6.2	10.8	6.3
11.2	6.2	11.3	6.4	10.8	6.4
10.8	6.4	10.9	6.3	11.2	6.5
10.6	6.2	11.4	6.4	10.9	6.2
11.2	6.3	11.2	6.2	10.7	6.4
10.960	6.200	11.2	6.300	10.880	6.360

Average: Warp 11.013 Filling 6.287

Sample 6

Tension, Warp 80 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
8.6	6.7	9.6	6.9	9.4	6.6
8.8	6.5	9.8	7.1	9.5	6.7
8.4	6.4	9.5	7.2	9.4	6.5
8.6	7.0	9.4	6.8	9.6	6.4
8.5	6.6	9.8	7.0	9.5	6.6
8.580	6.640	9.62	7.000	9.480	6.56

Average: Warp 9.227 Filling 6.733

(continued)

Table 19. Effects of Tension on Greige Crimp Per Cent
Using Brighton Crimp Tester (continued)

Sample 7

Tension, Warp 40 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
13.4	5.1	12.2	5.8	12.6	5.7
13.2	4.9	12.4	5.6	12.4	5.6
13.5	5.2	12.0	5.9	12.7	5.8
13.1	4.9	12.4	5.8	12.4	5.7
13.4	5.0	12.5	5.8	12.5	5.7
13.32	5.020	12.300	5.780	12.520	5.700

Average: Warp 12.713 Filling 5.500

Sample 8

Tension, Warp 60 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
10.6	5.8	11.4	5.8	12.2	6.2
10.6	5.6	11.2	6.2	12.3	6.1
10.5	5.8	11.4	5.9	12.1	6.4
10.6	5.9	11.2	6.0	12.0	5.9
10.6	5.8	11.3	5.8	12.2	6.2
10.540	5.780	11.300	5.940	12.160	6.160

Average: Warp 11.333 Filling 5.960

Sample 9

Tension, Warp 80 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
9.8	6.8	9.6	6.6	8.6	6.4
9.6	6.7	9.8	6.8	8.4	6.2
9.6	6.9	10.0	6.4	8.4	6.2
9.8	6.7	9.9	6.4	8.5	6.3
9.9	6.8	9.9	6.6	8.5	6.4
9.740	6.780	9.84	6.560	8.480	6.300

Average: Warp 9.353 Filling 6.547

Table 20. Effects of Tension on Sanforized Crimp Per Cent

Sample 1

Tension: Warp 40 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
15.20	12.00	14.00	11.90	14.10	11.70
15.40	11.80	14.10	12.00	14.60	11.40
15.40	12.00	13.90	12.00	14.20	11.20
15.20	12.20	13.80	11.80	14.50	11.00
15.20	12.00	14.00	12.10	14.30	11.30
15.28	12.00	13.96	11.96	14.34	11.32

Average: Warp 14.53 Filling 11.76

Sample 2

Tension: Warp 60 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
16.00	11.40	14.40	11.40	14.60	11.20
15.80	11.60	14.60	11.20	14.80	11.40
16.20	11.60	14.00	11.60	14.80	11.50
16.00	11.60	14.20	11.40	14.70	11.30
15.90	11.40	14.30	11.40	14.70	11.40
15.98	11.52	14.30	11.40	14.72	11.36

Average: Warp 15.00 Filling 11.43

Sample 3

Tension: Warp 80 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
15.80	10.60	15.80	11.40	15.20	11.00
15.60	10.80	16.20	11.20	15.00	10.80
15.80	11.00	16.40	11.60	15.40	11.20
16.10	10.90	16.00	11.40	15.20	11.00
15.80	10.80	15.90	11.00	15.20	11.40
15.82	10.82	16.06	11.32	15.20	11.08

Average: Warp 15.69 Filling 11.07

(continued)

Table 20. Effects of Tension on Sanforized Crimp Per Cent (continued)

Sample 4

Tension: Warp 40 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
12.60	11.40	14.80	11.20	13.80	11.80
12.60	11.60	15.00	11.40	14.40	12.00
12.40	11.60	14.60	11.20	14.20	12.20
12.60	11.70	15.00	11.30	13.90	12.20
12.60	11.60	14.88	11.40	14.00	12.00
12.56	11.58	14.84	11.30	14.06	12.04

Average: Warp 13.82 Filling 11.64

Sample 5

Tension: Warp 60 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
14.80	10.80	15.80	11.20	16.20	11.40
14.60	10.60	16.00	11.40	16.40	11.80
14.80	10.90	16.20	11.40	16.00	11.60
14.80	10.90	15.80	11.20	16.40	11.40
14.50	10.70	15.90	11.30	16.20	11.60
14.70	10.78	15.94	11.30	16.24	11.56

Average: Warp 15.63 Filling 11.21

Sample 6

Tension: Warp 80 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
15.60	9.80	15.60	9.90	15.90	10.00
16.00	9.90	15.80	9.80	16.00	9.80
15.80	9.80	15.90	10.00	15.80	9.70
16.00	10.00	15.70	10.20	15.90	9.70
15.80	9.90	15.60	10.10	15.70	9.90
15.84	9.88	15.72	10.00	15.86	9.82

Average: Warp 15.80 Filling 9.90

(continued)

Table 20. Effects of Tension on Sanforized Crimp Per Cent (continued)

Sample 7

Tension: Warp 40 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
14.60	11.00	14.80	10.80	14.50	11.00
14.50	11.20	14.60	11.20	14.40	11.20
15.00	10.80	14.80	11.40	14.60	11.40
14.80	11.20	15.00	11.00	14.80	11.10
14.60	11.00	14.80	11.20	14.90	11.20
14.70	11.04	14.80	11.12	14.64	11.18

Average: Warp 14.71 Filling 11.11

Sample 8

Tension: Warp 60 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
15.40	10.30	14.60	11.40	15.80	11.40
15.80	10.80	14.80	11.80	15.60	11.60
16.20	10.80	14.80	11.60	15.60	11.60
15.80	10.70	15.00	11.20	15.80	11.20
15.80	10.90	14.80	11.40	15.90	11.40
15.80	10.70	14.80	11.48	15.74	11.44

Average: Warp 15.45 Filling 11.21

Sample 9

Tension: Warp 80 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
15.20	10.80	16.20	10.80	16.00	10.90
14.80	10.60	15.80	10.70	15.80	11.00
15.00	10.90	16.00	10.90	15.80	11.00
15.40	11.00	16.20	11.00	16.00	10.90
15.20	11.10	16.30	10.80	16.20	11.20
15.12	10.88	16.10	10.84	15.96	11.00

Average: Warp 15.73 Filling 10.91

Table 21. Effects of Tension on Greige Shrinkage
18" Markings

Sample 1

Tension, Warp 40 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
15.74"	17.10"	15.83"	17.16"	15.83"	17.05"
15.74"	17.10"	15.83"	17.04"	15.83"	17.02"
15.72"	17.04"	15.84"	17.03"	15.78"	17.01"
15.66"	17.08"	15.83"	17.02"	15.80"	17.01"
15.72"	17.14"	15.83"	17.03"	15.75"	17.10"
15.72"	17.09"	15.83"	17.06"	15.80"	17.04"

Average: Warp 15.78" Shrinkage 2.22" Per Cent 12.33
Filling 17.06" Shrinkage .94" Per Cent 5.22

Sample 2

Tension, Warp 60 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
15.71"	17.10"	15.77"	17.16"	15.54"	16.98"
15.69"	17.06"	15.72"	17.14"	15.59"	16.98"
15.69"	17.06"	15.71"	17.16"	15.66"	16.98"
15.69"	17.04"	15.69"	17.18"	15.72"	17.04"
15.60"	17.08"	15.68"	17.23"	15.72"	17.06"
15.68"	17.07"	15.71"	17.17"	15.65"	17.01"

Average: Warp 15.68" Shrinkage 2.32" Per Cent 12.89
Filling 17.08" Shrinkage .92" Per Cent 5.11

(continued)

Table 21. Effects of Tension on Greige Shrinkage
18" Markings (continued)

Sample 3

Tension, Warp 80 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
15.74"	17.06"	15.70"	17.04"	15.56"	17.18"
15.74"	17.09"	15.70"	17.04"	16.04"	17.17"
15.70"	17.08"	15.71"	17.06"	16.64"	17.04"
15.70"	17.12"	15.71"	17.07"	15.51"	16.99"
15.70"	17.12"	15.70"	17.14"	15.51"	17.00"
15.72"	17.09"	15.70"	17.07"	15.57"	17.08"

Average: Warp 15.66" Shrinkage 2.34" Per Cent 13.00
Filling 17.09" Shrinkage .91" Per Cent 5.06

Sample 4

Tension, Warp 40 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
16.26"	17.16"	16.15"	17.06"	16.26"	17.24"
16.16"	17.18"	16.16"	17.06"	16.20"	17.22"
16.20"	17.18"	16.06"	17.04"	16.11"	17.22"
16.22"	17.16"	16.06"	17.06"	16.09"	17.20"
16.20"	17.16"	16.10"	17.10"	16.08"	17.20"
16.21"	17.17"	16.11"	17.06"	16.15"	17.21"

Average: Warp 16.16" Shrinkage 1.84" Per Cent 10.22
Filling 17.15" Shrinkage .85" Per Cent 4.72

(continued)

Table 21. Effects of Tension on Greige Shrinkage
18" Markings (continued)

Sample 5

Tension, Warp 60 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
16.03"	17.34"	15.96"	17.22"	15.94"	17.28"
16.03"	17.26"	15.98"	17.22"	15.96"	17.22"
15.98"	17.25"	15.96"	17.19"	15.96"	17.14"
15.98"	17.16"	15.96"	17.16"	16.04"	17.17"
15.99"	17.14"	15.96"	17.18"	16.04"	17.23"
16.00"	17.23"	15.96"	17.19"	15.99"	17.21"

Average: Warp 15.98" Shrinkage 2.02" Per Cent 11.22
Filling 17.21" Shrinkage .79" Per Cent 4.39

Sample 6

Tension, Warp 80 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
15.91"	17.30"	15.99"	17.27"	15.94"	17.06"
15.89"	17.30"	16.06"	17.34"	15.94"	16.93"
15.85"	17.28"	15.91"	17.42"	15.87"	17.10"
15.82"	17.25"	15.91"	17.40"	15.84"	17.14"
15.82"	17.20"	16.08"	17.42"	15.85"	17.18"
15.86"	17.27"	15.99"	17.37"	15.89"	17.08"

Average: Warp 15.91" Shrinkage 2.09" Per Cent 11.61
Filling 17.24" Shrinkage .76" Per Cent 4.22

(continued)

Table 21. Effects of Tension on Greige Shrinkage
18 Markings (continued)

Sample 7

Tension, Warp 40 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
16.02"	17.14"	15.90"	16.99"	16.08"	17.02"
16.02"	17.10"	15.90"	16.94"	16.10"	17.02"
16.20"	17.06"	15.96"	16.91"	16.06"	16.94"
16.22"	17.02"	15.98"	16.86"	15.99"	16.94"
16.25"	17.04"	15.96"	16.88"	15.96"	16.98"
16.14"	17.07"	15.94"	16.92"	16.04"	16.98"

Average: Warp 16.04" Shrinkage 1.96" Per Cent 10.89
Filling 16.99" Shrinkage 1.01" Per Cent 5.61

Sample 8

Tension, Warp 60 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
15.95"	17.18"	15.95"	17.16"	15.87"	16.99"
15.91"	17.22"	15.96"	17.16"	15.81"	17.02"
15.98"	17.19"	15.98"	17.21"	15.77"	16.98"
16.08"	17.19"	15.94"	17.25"	15.72"	17.00"
16.04"	17.18"	15.95"	17.22"	15.78"	17.06"
15.99"	17.19"	15.96"	17.20"	15.79"	17.01"

Average: Warp 15.91" Shrinkage 2.09" Per Cent 11.61
Filling 17.13" Shrinkage .87" Per Cent 4.83

(continued)

Table 21. Effects of Tension on Greige Shrinkage
18" Markings (continued)

Sample 9

Tension, Warp 80 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
15.91"	17.27"	15.86"	17.10"	15.82"	17.19"
15.96"	17.22"	15.82"	17.12"	15.88"	17.15"
16.05"	17.18"	15.82"	17.07"	15.89"	17.07"
16.05"	17.18"	15.82"	17.10"	15.80"	17.08"
16.04"	17.20"	15.84"	17.16"	15.84"	17.08"
16.00"	17.21"	15.83"	17.11"	15.85"	17.11"

Average: Warp 15.89" Shrinkage 2.11" Per Cent 11.72
Filling 17.14" Shrinkage .86" Per Cent 4.78

Table 22. Effects of Tension on Sanforized Shrinkage
18" Markings

Sample 1

Tension: Warp 40 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
18.26"	17.95"	18.19"	17.82"	18.18"	17.88"
18.28"	17.90"	18.22"	17.83"	18.19"	17.85"
18.29"	17.90"	18.24"	17.87"	18.18"	17.82"
18.29"	17.88"	18.25"	17.82"	18.18"	17.83"
18.28"	17.88"	18.24"	17.82"	18.18"	17.82"
18.26"	17.90"	18.23"	17.83"	18.18"	17.84"

Average: Warp 18.22" Shrinkage .22" Per Cent 1.22
Filling 17.86" Shrinkage -.14" Per Cent - .77

Sample 2

Tension: Warp 60 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
18.14"	17.88"	18.23"	17.82"	18.04"	17.88"
18.16"	17.83"	18.21"	17.83"	18.02"	17.81"
18.63"	17.86"	18.22"	17.83"	18.04"	17.78"
18.22"	17.85"	18.24"	17.82"	18.04"	17.78"
18.24"	17.88"	18.23"	17.82"	18.05"	17.79"
18.28"	17.86"	18.23"	17.82"	18.04"	17.81"

Average: Warp 18.18" Shrinkage .18" Per Cent 1.00
Filling 17.83" Shrinkage -.17" Per Cent .94

(continued)

Table 22. Effects of Tension on Sanforized Shrinkage
18" Markings (continued)

Sample 3

Tension: Warp 80 grams, Filling 12 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
18.06"	17.88"	18.33"	17.82"	18.12"	17.88"
18.05"	17.86"	18.36"	17.86"	18.16"	17.90"
18.06"	17.85"	18.36"	17.87"	18.19"	17.91"
18.08"	17.87"	18.36"	17.86"	18.24"	17.90"
18.07"	17.88"	18.38"	17.82"	18.25"	17.88"
18.06"	17.87"	18.36"	17.85"	18.20"	17.89"

Average: Warp 18.20" Shrinkage .20" Per Cent 1.11
Filling 17.87" Shrinkage -.13" Per Cent - .72

Sample 4

Tension: Warp 40 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
17.95"	17.85"	17.85"	17.79"	18.01"	17.82"
18.00"	17.90"	17.87"	17.84"	18.06"	17.83"
18.00"	17.85"	17.88"	17.78"	18.09"	17.83"
17.95"	17.83"	17.88"	17.82"	18.09"	17.82"
17.95"	17.80"	17.93"	17.78"	18.06"	17.81"
17.97"	17.85"	17.88"	17.80"	18.06"	17.82"

Average: Warp 17.97" Shrinkage .03" Per Cent .16
Filling 17.82" Shrinkage .18" Per Cent 1.00

(continued)

Table 22. Effects of Tension on Sanforized Shrinkage
18" Markings (continued)

Sample 5

Tension: Warp 60 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
18.12"	17.71"	18.21"	17.82"	18.02"	17.83"
18.07"	17.74"	18.22"	17.78"	18.04"	17.82"
18.04"	17.81"	18.19"	17.81"	18.07"	17.78"
18.04"	17.81"	18.24"	17.77"	18.09"	17.78"
18.05"	17.78"	18.25"	17.77"	18.07"	17.76"
18.06"	17.77"	18.22"	17.79"	18.06"	17.79"

Average: Warp 18.11" Shrinkage .11" Per Cent .61
Filling 17.78" Shrinkage .22" Per Cent 1.22

Sample 6

Tension: Warp 80 grams, Filling 24 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
18.09"	17.88"	18.07"	17.78"	18.16"	17.82"
18.12"	17.83"	18.09"	17.79"	18.18"	17.85"
18.14"	17.86"	18.12"	17.77"	18.18"	17.86"
18.14"	17.76"	18.14"	17.77"	18.15"	17.88"
18.00"	17.88"	18.13"	17.78"	18.15"	17.88"
18.09"	17.84"	18.11"	17.78"	18.16"	17.84"

Average: Warp 18.12" Shrinkage .12" Per Cent .66
Filling 17.82" Shrinkage .18" Per Cent 1.00

(continued)

Table 22. Effects of Tension on Sanforized Shrinkage
18" Markings (continued)

Sample 7

Tension: Warp 40 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
18.07"	17.82"	18.17"	17.76"	18.09"	17.78"
18.05"	17.82"	18.19"	17.78"	18.13"	17.81"
18.02"	17.80"	18.19"	17.79"	18.15"	17.81"
18.02"	17.77"	18.21"	17.81"	18.15"	17.78"
18.03"	17.86"	18.22"	17.81"	18.14"	17.78"
18.04"	17.81"	18.20"	17.79"	18.13"	17.79"

Average: Warp 18.12" Shrinkage .12" Per Cent .66
Filling 17.79" Shrinkage .21" Per Cent 1.16

Sample 8

Tension: Warp 60 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
18.29"	17.74"	18.09"	17.76"	17.90"	17.76"
18.31"	17.76"	18.11"	17.77"	17.94"	17.79"
18.34"	17.76"	18.13"	17.79"	17.94"	17.81"
18.33"	17.78"	18.14"	17.78"	17.95"	17.81"
18.36"	17.79"	18.19"	17.79"	18.01"	17.83"
18.33"	17.76"	18.13"	17.78"	17.95"	17.80"

Average: Warp 18.14" Shrinkage .14" Per Cent .78
Filling 17.78" Shrinkage .22" Per Cent 1.22

(continued)

Table 22. Effects of Tension on Sanforized Shrinkage
18" Markings (continued)

Sample 9

Tension: 80 grams, Filling 36 grams

A		B		C	
Warp	Filling	Warp	Filling	Warp	Filling
18.24"	17.84"	18.22"	17.79"	18.22"	17.81"
18.26"	17.82"	18.24"	17.78"	18.24"	17.81"
18.28"	17.83"	18.23"	17.74"	18.26"	17.83"
18.28"	17.82"	18.23"	17.74"	18.25"	17.84"
18.27"	17.82"	18.26"	17.72"	18.26"	17.84"
18.27"	17.82"	18.24"	17.75"	18.25"	17.83"

Average: Warp 18.25" Shrinkage .25" Per Cent 1.38
Filling 17.80" Shrinkage .20" Per Cent 1.11

Table 23. Effects of Tension on Greige Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart

Sample 1

Tension: Warp 10 grams, Filling 12 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	77.0	16.0		58.5	13.0	
	84.0	16.5		60.0	13.5	
	89.0	17.5		62.5	12.5	
	93.0	17.5		63.0	15.0	
	94.5	17.5		64.5	13.0	
	87.5	17.0	17.7	61.7	13.4	13.9
B	82.0	19.5		56.0	11.5	
	85.5	19.5		57.5	10.0	
	89.5	20.5		58.0	11.0	
	90.5	21.5		59.5	12.5	
	86.5	21.5		60.0	11.5	
	86.8	20.5	21.3	58.2	11.1	11.5
C	80.5	20.5		60.5	11.5	
	87.5	20.5		61.0	11.5	
	88.0	21.0		61.5	12.0	
	92.0	21.0		62.0	12.5	
	92.0	22.5		62.0	13.0	
	89.4	21.1	22.0	61.5	12.1	12.6

Average: Warp: Break 87.9 Filling: Break 60.5
Elongation 20.3 Elongation 12.7

(continued)

Table 23. Effects of Tension on Greige Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 2

Tension: Warp 60 grams, Filling 12 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	82.5	17.5		52.0	11.5	
	84.5	18.0		60.5	11.0	
	85.0	19.5		62.0	11.5	
	87.5	18.5		62.0	11.5	
	89.0	18.5		63.5	12.0	
	85.7	18.4	19.2	60.0	11.5	12.0
B	78.5	17.0		54.0	13.0	
	81.0	17.5		58.0	12.5	
	86.5	18.5		58.5	13.0	
	89.0	17.5		59.0	13.0	
	98.0	18.0		59.0	13.5	
	86.6	17.7	18.4	57.7	13.0	13.5
C	84.5	17.5		55.5	13.0	
	88.0	17.5		59.5	14.0	
	90.0	18.5		60.5	14.0	
	92.0	19.0		60.5	13.5	
	96.0	18.5		63.0	14.0	
	90.1	18.2	18.9	59.8	13.7	14.3

Average: Warp: Break 87.5 Filling: Break 59.2
Elongation 18.8 Elongation 13.2

(continued)

Table 23. Effects of Tension on Greige Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 3

Tension: Warp 80 grams, Filling 12 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	85.5	15.0		50.0	11.5	
	83.5	15.0		53.6	12.0	
	88.5	15.0		53.0	12.5	
	90.0	14.5		55.0	13.0	
	86.0	15.0		58.5	13.5	
	87.7	14.9	15.5	53.9	12.5	10.4
B	78.0	14.5		54.5	13.5	
	90.0	14.0		55.5	13.0	
	95.0	15.5		59.0	13.0	
	82.5	16.0		60.0	14.0	
	90.0	16.0		62.0	13.5	
	87.1	15.2	15.8	58.2	13.4	13.9
C	86.0	14.0		58.0	11.5	
	89.5	15.5		58.5	12.0	
	94.0	15.5		59.0	12.5	
	86.0	15.5		60.0	12.0	
	84.0	15.0		58.0	12.5	
	87.9	15.5	15.7	58.7	12.1	12.2

Average: Warp: Break 87.5 Filling: Break 56.9
Elongation 15.7 Elongation 12.2

(continued)

Table 23. Effects of Tension on Greige Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 4

Tension: Warp 40 grams, Filling 24 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	84.0	22.0		60.6	11.0	
	85.0	21.5		61.0	11.0	
	85.0	21.0		62.0	11.0	
	87.0	21.5		62.5	10.5	
	89.5	21.5		63.0	11.0	
	86.1	21.5	22.4	62.1	10.9	11.3
B	81.0	21.0		62.0	11.0	
	86.0	22.0		63.0	12.0	
	87.5	22.5		63.5	11.5	
	89.0	24.0		64.0	12.5	
	90.5	24.0		61.0	12.0	
	86.8	22.7	23.6	62.7	11.8	12.3
C	80.0	20.0		56.0	11.5	
	82.5	22.5		58.0	11.0	
	88.0	22.5		60.0	11.5	
	90.0	21.0		62.0	11.0	
	92.0	21.5		71.0	11.0	
	86.5	21.5	22.4	61.4	11.2	11.6

Average: Warp: Break 86.5 Filling: Break 62.1
Elongation 22.8 Elongation 11.8

(continued)

Table 23. Effects of Tension on Greige Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 5

Tension: Warp 60 grams, Filling 24 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	73.0	18.5		53.0	12.5	
	80.0	18.5		53.0	13.0	
	83.0	18.5		53.5	12.5	
	88.0	19.5		61.0	12.5	
	89.5	18.0		62.0	12.5	
	82.6	18.6	19.4	56.5	12.6	13.1
B	79.5	18.0		63.0	13.5	
	84.5	16.5		65.0	13.0	
	85.0	17.0		65.0	13.0	
	93.0	16.5		67.0	14.0	
	95.0	18.5		72.5	13.5	
	87.4	17.3	18.0	66.5	13.4	13.9
C	87.0	16.0		52.0	10.0	
	88.5	16.5		55.0	10.0	
	91.0	17.0		57.0	11.0	
	93.0	18.5		59.0	10.5	
	93.0	17.5		59.0	10.5	
	90.5	17.1	17.8	56.4	10.4	10.8

Average: Break 86.8 Filling: Break 59.8
Elongation 18.4 Elongation 12.6

(continued)

Table 23. Effects of Tension on Greige Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 6

Tension: Warp 80 grams, Filling 24 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	82.5	15.5		55.0	12.5	
	83.0	16.5		57.0	12.5	
	85.5	17.5		57.5	12.5	
	88.0	17.5		62.0	13.0	
	89.0	18.0		63.0	13.0	
	85.6	17.0	17.7	58.8	12.7	13.2
B	79.0	16.5		52.5	12.5	
	80.0	17.0		54.5	12.5	
	86.0	16.0		56.0	13.0	
	88.0	17.5		57.5	13.0	
	89.0	16.0		57.5	12.5	
	84.4	16.6	17.3	55.6	12.7	13.2
C	78.0	15.0		52.5	12.0	
	82.0	14.5		57.0	12.0	
	84.0	15.0		60.0	12.5	
	84.5	15.0		62.0	13.0	
	88.0	15.0		65.0	12.0	
	83.2	14.9	15.8	59.3	12.3	12.8

Average: Warp: Break 84.4 Filling: Break 57.9
Elongation 16.9 Elongation 13.1

(continued)

Table 23. Effects of Tension on Greige Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 7

Tension: Warp 40 grams, Filling 36 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	77.5	21.0		56.5	11.0	
	88.0	21.0		56.5	10.0	
	88.0	22.0		60.0	11.5	
	91.0	21.5		62.0	11.0	
	94.0	22.0		65.5	11.5	
	87.7	21.5	22.4	60.1	11.0	11.5
B	81.0	20.0		56.5	10.0	
	81.5	19.5		58.5	10.5	
	85.0	21.0		63.5	11.0	
	85.5	21.0		63.0	11.0	
	86.0	20.5		66.0	10.5	
	83.8	20.4	21.2	61.5	10.6	11.0
C	78.0	20.0		57.5	12.0	
	79.0	21.5		59.5	12.5	
	86.0	21.0		59.5	12.5	
	89.0	21.5		60.0	12.0	
	100.0	20.0		63.0	12.5	
	86.4	20.8	21.7	59.9	12.3	12.8

Average: Warp: Break 85.9 Filling: Break 60.5
Elongation 21.8 Elongation 11.8

(continued)

Table 23. Effects of Tension on Greige Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 8

Tension: Warp 60 grams, Filling 36 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	81.0	18.5		51.0	11.5	
	81.5	19.0		52.5	12.0	
	92.5	18.5		54.0	11.5	
	85.0	18.5		54.5	11.0	
	86.0	18.5		54.0	11.5	
	85.2	18.6	19.4	53.2	11.5	12.0
B	81.0	17.0		50.5	11.5	
	80.5	17.0		53.0	11.5	
	84.0	18.0		54.5	12.0	
	87.5	18.5		54.5	12.5	
	94.0	19.0		61.0	12.0	
	85.4	17.9	18.6	54.7	11.9	12.4
C	82.5	18.0		55.0	13.0	
	84.0	19.5		59.0	11.5	
	85.5	18.5		61.0	13.0	
	88.0	19.0		62.5	13.0	
	92.0	19.5		64.0	12.5	
	86.4	18.9	19.7	60.3	12.6	13.1

Average: Warp: Break 85.6 Filling: Break 56.1
Elongation 19.3 Elongation 12.5

(continued)

Table 23. Effects of Tension on Greige Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 9

Tension: Warp 80 grams, Filling 36 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	85.0	18.5		50.0	13.0	
	87.0	18.0		58.0	13.5	
	87.0	17.0		58.5	13.0	
	86.0	18.5		55.5	13.5	
	81.5	19.0		50.0	13.5	
	85.3	18.2	18.9	54.3	13.3	13.8
B	81.0	18.0		52.0	12.0	
	82.5	17.5		54.0	11.0	
	86.0	18.5		57.0	12.0	
	87.0	17.0		57.0	12.0	
	90.5	18.5		58.0	12.5	
	85.4	17.9	18.6	55.6	11.9	12.4
C	81.0	17.5		50.5	11.0	
	86.0	17.0		51.0	11.0	
	86.0	18.0		53.5	11.0	
	84.0	16.5		53.5	10.5	
	82.0	16.5		56.0	11.5	
	83.6	17.1	17.8	52.9	11.3	11.8

Average: Warp: Break 84.8 Filling: Break 54.3
Elongation 18.4 Elongation 12.7

Table 24. Effects of Tension on Sanforized Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart

Sample 1

Tension: Warp 40 grams, Filling 12 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	83.0	26.0		58.0	20.5	
	86.0	25.0		60.5	20.5	
	87.0	25.0		61.0	19.0	
	88.0	25.0		65.0	18.0	
	93.0	26.0		65.5	18.0	
	87.4	25.4	26.4	62.0	19.2	20.0
B	83.0	22.5		58.0	18.0	
	84.5	21.0		58.0	19.0	
	86.0	22.5		58.5	20.0	
	87.0	21.5		60.0	20.0	
	92.0	22.0		61.0	20.0	
	86.5	21.9	22.8	59.1	19.4	20.2
C	83.0	25.5		66.0	20.0	
	84.0	25.0		66.5	20.0	
	86.5	25.0		68.0	21.0	
	88.0	24.0		69.0	19.0	
	89.0	24.5		69.5	20.0	
	86.1	24.8	25.8	67.8	20.0	20.8

Average: Warp: Break(lbs.) 86.7 Filling: Break(lbs.) 62.9
Elongation(%) 25.0 Elongation(%) 20.3

(continued)

Table 24. Effects of Tension on Sanforized Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 2

Tension: Warp 60 grams, Filling 12 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	89.0	28.0		69.5	21.5	
	92.0	27.5		62.0	21.0	
	94.0	27.5		62.5	22.5	
	99.0	28.0		62.5	20.5	
	103.5	26.5		63.5	21.5	
	95.5	27.5	28.6	62.0	21.4	22.3
B	85.0	27.0		68.0	21.0	
	86.0	27.0		69.5	21.0	
	89.5	26.0		62.0	22.0	
	91.0	26.5		63.0	23.0	
	93.5	25.5		64.0	21.5	
	89.0	26.4	27.5	61.3	21.7	22.6
C	89.5	27.5		62.0	20.5	
	94.0	27.5		62.0	21.0	
	93.5	27.5		63.0	19.5	
	97.0	26.5		63.5	19.5	
	98.0	26.0		71.0	19.5	
	94.4	27.0	28.0	64.0	20.0	20.8

Average: Warp: Break(lbs.) 92.9 Filling: Break(lbs.) 62.4
Elongation(%) 28.0 Elongation(%) 21.9

(continued)

Table 24. Effects of Tension on Sanforized Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 3

Tension: Warp 80 grams, Filling 12 grams

Sub-Sample	Break (lbs.)	Elongation (1/32")	Elongation (%)	Break (lbs.)	Elongation (1/32")	Elongation (%)
A	93.0	23.0		67.0	20.5	
	95.0	23.5		59.0	19.0	
	95.0	23.0		61.0	19.0	
	96.0	23.0		64.5	19.5	
	95.0	23.5		65.0	19.0	
	94.8	23.2	24.2	63.3	19.4	20.2
B	89.0	25.0		62.0	20.0	
	89.0	25.5		62.0	18.5	
	89.5	26.0		63.0	18.5	
	92.5	25.5		67.0	19.5	
	96.0	26.0		68.0	19.5	
	91.2	25.6	26.7	64.4	19.2	20.0
C	84.5	28.5		58.0	20.0	
	93.0	27.0		61.0	19.5	
	96.0	27.0		64.0	18.0	
	96.5	27.5		66.5	20.0	
	98.5	25.5		67.0	18.0	
	93.7	27.1	28.2	63.3	19.1	19.9

Average: Warp: Break(lbs.) 93.2 Filling: Break(lbs.) 63.7
Elongation(%) 26.4 Elongation(%) 20.0

(continued)

Table 24. Effects of Tension on Sanforized Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 4

Tension: Warp 40 grams, Filling 24 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	88.5	26.0		56.0	21.5	
	91.0	27.0		57.5	21.0	
	92.5	25.0		59.0	18.5	
	96.0	26.0		60.0	20.0	
	98.0	25.5		62.5	20.0	
	93.2	25.9	27.0	59.0	20.1	20.9
B	86.0	25.5		63.0	23.0	
	88.0	27.5		65.5	20.5	
	89.5	27.5		67.0	20.5	
	91.0	26.5		67.5	22.5	
	94.0	24.5		69.0	20.5	
	89.7	26.3	27.4	66.4	21.4	22.3
C	90.0	27.5		62.0	20.0	
	92.0	27.0		63.5	21.5	
	95.5	25.0		65.5	22.0	
	100.0	25.0		67.0	21.0	
	102.0	24.5		67.5	21.0	
	95.9	25.8	26.9	65.1	21.1	22.0

Average: Warp: Break(lbs.) 92.9 Filling: Break(lbs.) 63.5
Elongation(%) 27.1 Elongation(%) 21.7

(continued)

Table 24. Effects of Tension on Sanforized Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 5

Tension: Warp 60 grams, Filling 24 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	82.0	26.0		60.0	18.0	
	89.0	24.0		64.5	19.5	
	92.0	24.0		65.0	16.5	
	92.0	25.0		65.0	18.0	
	98.0	25.0		67.0	17.5	
	90.6	24.8	25.8	64.3	17.9	18.7
B	81.0	27.0		63.0	18.0	
	87.0	24.0		64.5	20.0	
	95.0	26.0		65.5	20.0	
	97.0	24.5		66.0	18.0	
	98.0	24.0		67.0	17.5	
	91.6	25.1	26.1	65.2	18.7	19.5
C	84.0	22.0		62.0	20.5	
	86.0	24.5		63.0	19.0	
	86.5	24.0		66.0	19.0	
	87.0	24.5		67.0	19.5	
	87.5	23.5		68.0	19.0	
	86.2	23.7	24.7	65.2	19.4	20.2

Average: Warp: Break(lbs.) 89.5 Filling: Break(lbs.) 64.9
Elongation(%) 25.5 Elongation(%) 19.5

(continued)

Table 24. Effects of Tension on Sanforized Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 6

Tension: Warp 80 grams, Filling 24 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	85.0	25.5		66.0	18.5	
	88.0	24.0		68.0	18.5	
	88.5	25.5		66.0	20.0	
	90.5	27.5		69.5	19.5	
	94.5	26.5		71.5	17.5	
	89.3	25.8	26.9	68.2	18.8	19.6
B	88.0	24.5		59.0	20.5	
	89.0	24.0		60.5	19.5	
	89.5	24.5		63.5	19.0	
	90.5	24.0		66.0	19.0	
	97.0	24.0		66.5	20.5	
	90.8	24.2	25.2	63.1	19.7	20.5
C	92.0	26.0		57.0	20.0	
	93.0	26.0		58.0	20.0	
	94.5	26.0		63.5	20.5	
	94.5	25.0		67.0	20.5	
	95.0	24.0		68.0	19.5	
	93.8	25.4	26.4	62.7	20.1	20.9

Average: Warp: Break(lbs.) 91.3 Filling: Break(lbs.) 64.7
Elongation(%) 26.2 Elongation(%) 20.3

(continued)

Table 24. Effects of Tension on Sanforized Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart

Sample 7

Tension: Warp 40 grams, Filling 36 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	82.0	25.5		58.0	20.0	
	82.5	23.0		59.5	20.5	
	82.5	24.0		63.0	21.0	
	91.0	25.5		66.0	21.5	
	94.0	28.0		58.0	19.5	
	86.4	25.2	26.2	60.9	20.5	21.3
B	83.0	28.5		64.5	21.5	
	83.5	28.5		65.0	20.0	
	85.0	27.5		66.0	21.0	
	91.0	27.0		66.0	21.5	
	92.0	28.0		70.5	20.5	
	86.9	27.9	29.0	66.4	20.8	21.7
C	80.5	25.0		52.5	20.5	
	82.5	25.5		53.0	21.5	
	83.5	26.0		57.0	21.5	
	84.5	25.5		58.5	19.5	
	92.0	25.5		60.5	21.0	
	84.6	25.4	26.4	56.3	20.8	21.6

Average: Warp: Break(lbs.) 85.9 Filling: Break(lbs.) 61.2
Elongation(%) 27.2 Elongation(%) 21.5

(continued)

Table 24. Effects of Tension on Sanforized Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 8

Tension: Warp 60 grams, Filling 36 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	83.5	27.5		58.0	21.5	
	84.0	28.0		62.5	22.0	
	91.0	28.0		63.0	22.0	
	93.0	29.0		68.0	22.0	
	98.5	26.5		74.5	21.0	
	90.0	27.8	28.9	65.2	21.7	22.6
B	77.0	29.0		67.0	20.0	
	85.0	28.5		67.5	19.5	
	88.0	28.0		67.5	21.0	
	91.0	28.5		68.0	22.0	
	99.0	27.0		70.0	19.5	
	88.0	28.2	29.4	68.0	20.4	21.2
C	80.0	27.5		59.0	20.5	
	83.5	27.0		60.0	21.5	
	87.0	28.0		60.0	19.0	
	88.0	26.0		63.0	20.5	
	92.0	27.0		64.0	20.0	
	86.1	27.1	28.2	61.2	20.3	21.1

Average: Warp: Break(lbs.) 88.0 Filling: Break(lbs.) 64.8
Elongation(%) 28.8 Elongation(%) 21.6

(continued)

Table 24. Effects of Tension on Sanforized Breaking Strength and Elongation
Ravel Strip, Jaws Set 3" Apart (continued)

Sample 9

Tension: Warp 80 grams, Filling 36 grams

Sub-Sample	Warp Break (lbs.)	Warp Elongation (1/32")	Warp Elongation (%)	Filling Break (lbs.)	Filling Elongation (1/32")	Filling Elongation (%)
A	83.0	27.5		62.0	19.0	
	91.0	27.0		65.0	19.5	
	92.0	26.0		66.0	19.5	
	93.0	24.5		66.0	18.5	
	93.0	25.0		68.0	19.5	
	90.4	26.0	27.1	65.4	19.2	20.0
B	82.0	29.0		62.0	21.0	
	83.0	29.0		65.0	21.5	
	88.0	29.5		66.5	22.5	
	88.5	27.0		67.5	22.0	
	90.5	26.5		70.0	21.5	
	86.4	28.2	29.4	66.2	21.7	22.6
C	82.0	22.5		69.5	21.0	
	85.0	24.0		69.0	22.0	
	88.0	23.0		69.0	19.0	
	93.0	22.5		64.5	21.5	
	93.5	21.5		64.5	21.5	
	88.3	22.7	23.6	67.3	21.0	21.9

Average: Warp: Break(lbs.) 88.4 Filling: Break(lbs.) 66.3
Elongation(%) 26.7 Elongation(%) 21.5

Table 25. Effects of Tension on Bow

Sample 1

Tension: Warp 40 grams, Filling 24 grams

A	B	C	Average
.625 in.	.688 in.	.656 in.	.656 in.

Width 44.613 in. Bow 1.47%

Sample 2

Tension: Warp 60 grams, Filling 24 grams

A	B	C	Average
.688 in.	.750 in.	.781 in.	.739 in.

Width 44.288 in. Bow 1.66%

Sample 3

Tension: Warp 80 grams, Filling 24 grams

A	B	C	Average
1.000 in.	1.031 in.	1.000 in.	1.010 in.

Width 44.109 in. Bow 2.29%

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